Sensory Integration Theory Revisited 1

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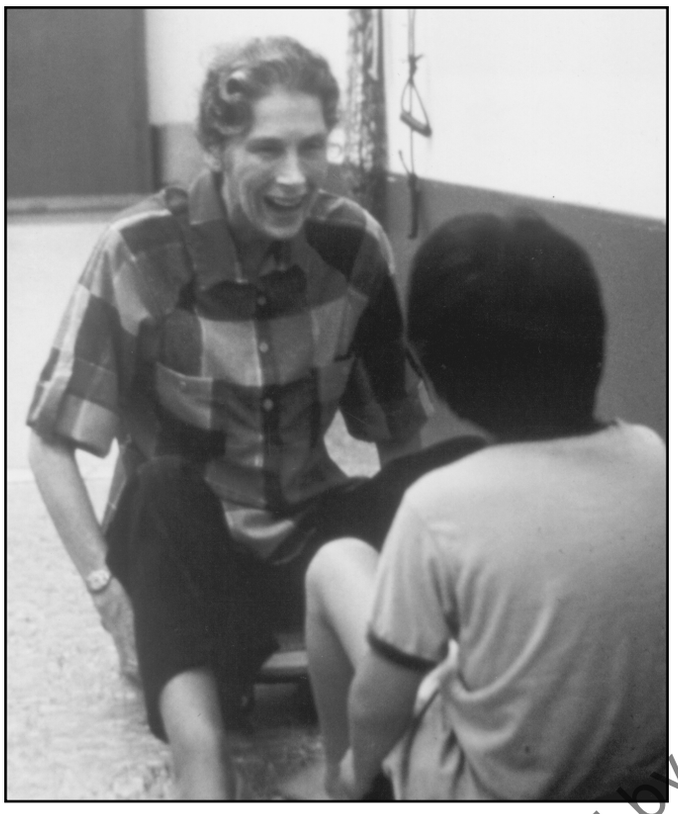
INTRODUCTION

Sensory integration theory, research, assessment, intervention, and therapeutic equipment were originated by Dr. A. Jean Ayres, a visionary occupational therapist and educational psychologist. She formulated the theory of sensory integration and its application for individuals with disabilities, in part by considering the contribution of covert neural and behavioral processes not previously considered and by reviewing literature from the fields of neurology, neurophysiology, psychology, motor learning and motor control, education, and occupational science that supported her ideas on the function of what she termed "sensory integration." She was the first occupational therapist to systematically research the application of her theories in practice, setting the standard for empirically-based research as the basis for clinical decision making.

Ayres began her research in the 1960s in the perceptual motor era and continued her research in test development, factor and cluster analyses, and efficacy of intervention throughout her career. In the 1960s, she developed individual tests that were published together as the *Southern California Sensory Integration Tests* (SCSIT; Ayres, 1972b) and established herself as an eminent perceptual motor theorist. By the 1970s, she had conducted numerous research studies to validate her theories. Her work established a unique role for occupational therapists in the area of treating learning disabilities. Ayres and her colleagues eventually established a national organization with faculty to teach her theories and assessment methods across the United States. Dr. Ayres also established a university-affiliated clinical training program at the University of Southern California that continues today. During the 1980s, she continued to work in test development, particularly in the area of praxis, restandardizing the SCSIT, which is now known as the *Sensory Integration and Praxis Tests* (SIPT; Ayres, 1989).

Sensory integration theory is an evolving theory, rather than a static collection of facts. *The theory is based on nonlinear relationships among dynamically interrelated neurobiological and functional systems.* Sensory integration theory explains the ways in which an individual takes in information about the environment in relation to the environmental conditions (Ayres, 1972a). Ayres applied her theories to a wide variety of disabilities and across age groups, proposing that improved sensory integration increased adaptive behavior and well-being. Ayres trusted that the innate drive of the individual to learn and grow emerged when provided with the optimal environment, a fun and playful motivation to engage, and "just-right" challenges. She applied her science in an artful, playful, and child-directed manner, emphasizing the importance of adaptive responses and self-direction. She designed therapeutic strategies that have been used in the clinic, home, community, and schools. With help from her husband, Franklin Baker, Dr. Ayres also designed and fabricated the unique equipment used with the sensory integrative approach.



Dr. Ayres developed a fun and effective approach to remediating hidden disabilities affecting learning and behavior. ***(Photo by Karen A. Pettit.)***

Neurobiological Processes in Sensory Integration

Ayres (1972a) described sensory integration as the central nervous system translating information into action. Her theory was based on the idea that behavior is linked to neurological processes, and that brain stem-level sensory processing enables higher neural centers to develop and specialize. She proposed that disorganized neuronal processes led to disorganized behaviors. She hypothesized that by providing enriched sensory opportunities processed at the level of the brain stem, and by stimulating the child's motivation via the limbic system with the "just-right" sensory and motor challenges, the child would make generalizable higher level adaptive responses and be more willing to tackle challenges in every day life. Her interventions focused on activating the child's innate drive to engage and grow through pleasurable, but challenging, sensory-motor activities leading to increasingly more complex somatomotor adaptive responses.

More Than Five Senses

Although the five senses known as taste, smell, touch, vision, and hearing are common knowledge, there are actually additional sensations that provide information about what is going on within the body itself. All sensations lie within three primary categories: interoception, proprioception, and exteroception. Combined, the sensations from these

three areas provide an individual with essential and interesting information about him- or herself and the environment.

1. Interoception
   - Sensation from inside the body
   - Perceived through internal organs or viscera
   - Example: The feeling of hunger or fullness in the stomach
2. Proprioception
   - Sensation about body position and movement
   - Perceived through vestibular, proprioceptive, and kinesthetic sensory systems
   - Example: The feeling of the head turning and of muscles contracting
3. Exteroceptors
   - Sensation from outside of the body
   - Perceived through taste, smell, touch, hearing, and vision
   - Example: Seeing a friend and hearing your name being called

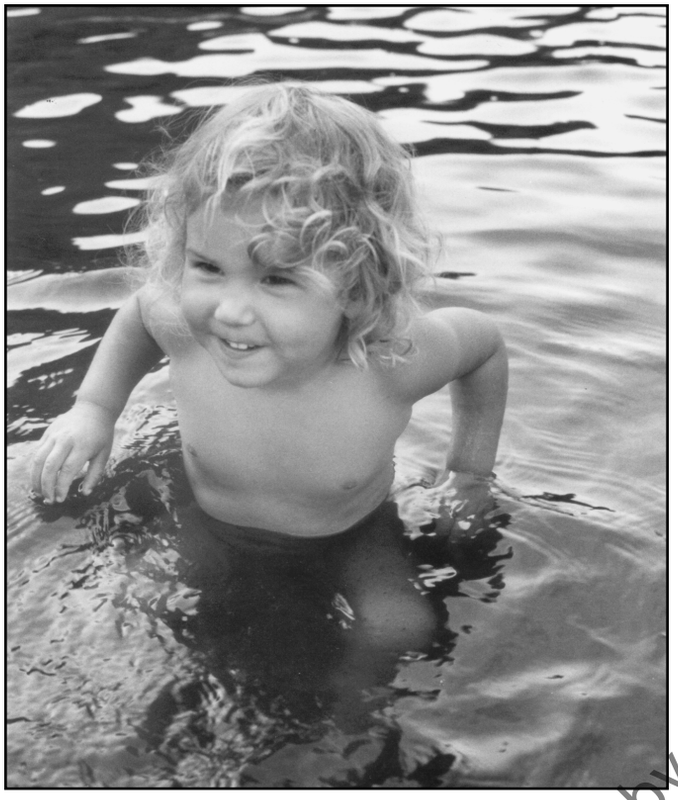
Ayres was the first to emphasize the importance of these "hidden sensations" that an individual processes about his or her body and the interactions of those body-centered sensations (interoceptors and proprioceptors) with sensations from outside of the body (exteroceptors). She noted a disorder in processing and integrating sensory information known as *sensory integration dysfunction* that is specifically identified as the inability to process and integrate information from the body and the environment.

Development and Sensory Integration

Development unfolds as the interplay between genetics, health, physical capabilities, and environmental influences. Likewise, the child's capacity to process sensory information develops as his or her capabilities emerge and are influenced by culture, environment, caregiving, and social support. As the child perceives, interprets, analyzes, and integrates sensory information, he or she gains knowledge about his or her body and the environment, which forms an important basis for learning and development.

Foundation for Learning and Behavior

Ayres' definition of sensory integration continues to serve as the blueprint for sensory integration theory and practice: "Sensory integration is the organization of sensation for use" (1979, p. 5). She noted that *perceiving* and *knowing* are essential to an individual's ability to pay attention, learn, plan, and do things; or in other words, engage in functional, meaningful, adaptive behaviors or occupations.



During typical development, children experience the joy of sensory immersion in their environment.
(Photo by Shay McAtee.)

Prerequisite for Occupational Engagement

Ayres believed that the integration of sensation within the central nervous system provides an important foundation for individuals to engage in meaningful, health-promoting occupations that support participation in life. She focused the outcome of intervention on the satisfaction and improved self-esteem that ensues from enhanced perceptual awareness and adaptability so that the individual can do things that he or she has not done before.

Sensory Integration Today

Ayres' original ideas and assessment methods continue to be applicable today. Her ideas about the neurobiological contributions to function are well accepted (Kandel, Schwartz, & Jessell, 2000; Bear, Connors, & Paradiso, 1996). Research in intersensory associations and perception validate her theories about the dynamically interrelated processes that contribute to perception and function (Lewkowicz & Lickliter, 1994; Calvert, Spence, & Stein, 2004). Although Ayres discussed a hierarchical neurological system, she described functions that were, in fact, interactive and dynamic. Current theory is that every human action involves integrated neurological processes from sensory, motor, and other cognitive and emotional systems (Kandel, Schwartz, & Jessell, 2000). Research on neuroplasticity continues to support the ideas that appropriate and enriched environments have a positive impact on brain function throughout the life span. (See chapters 1–5 in *Understanding the Nature of Sensory Integration With Diverse Populations* [Smith Roley, Blanche, & Schaaf, 2001] for detailed information.)

Application of Sensory Integration Principles in Therapeutic Practice

Identifying Appropriate Candidates for Therapy

Based on Ayres' research in the 1970s, intervention based on sensory integration principles became well known for its use with children experiencing difficulties with learning and behavior. Ayres proposed that sensory integration deficits in this population of children did not reflect frank neurological damage, but rather deficits in the central processing of information. These children were difficult to assess with traditional methods. Only through standardized administrations of the SIPT, and documentation of observations, is the therapist able to objectively identify children with patterns of dysfunction that are appropriate for intervention. Ayres never intended to exclude individuals with significant or defined impairments or diagnoses from her methods of intervention (Brown, 1974). Individuals with neurological damage commonly have deficits in information processing functions, including the processing of sensory information. The importance of the book, *Understanding the Nature of Sensory Integration With Diverse Populations* (Smith Roley et al., 2001), is that it expanded the application of sensory integration theory as a frame of reference and illustrated how it can be used with one or more other frames of reference to make diagnoses among a variety of individuals. Table 1.1 includes some, but not all, of the diagnostic groups that may benefit from the use of sensory integrative principles.

Table 1.1
Common Diagnostic Groups With Sensory Integrative Deficits

Attention Deficit	Autistic Spectrum Disorders
Cerebral Palsy	Developmental Delay
Environmentally Deprived	Fragile X Syndrome
Genetic Disorders (e.g., Down Syndrome)	Hearing Impairment
High-Risk Infants	Learning Disabilities
Mental Retardation	Traumatic Brain Injury
Visual Impairment and Blindness	

Reasons for Referral

What are the primary reasons someone might be referred for a professional evaluation, targeting sensory integrative functions?

Typically, referrals for occupational therapy are based on the client's difficulties participating in everyday skills and activities according to needed or desired expectations in one or more areas of occupation. An occupational therapy evaluation is completed to

identify the source of these difficulties. The areas of occupation that are evaluated include, but are not limited to:

- activities of daily living;
- education;
- participation in play and leisure activities at home and in the community;
- social participation; and
- performance skills and patterns, including habits and routines.

These areas of occupation are defined in the *Occupational Therapy Practice Framework: Domain and Process* (American Occupational Therapy Association [AOTA], 2002).

Affected Areas of Occupation

What areas of occupation may be recognizably affected by sensory integrative dysfunction?

Sensory integration and praxis deficits are specific areas of dysfunction that may be one of many contributors to a child's difficulty engaging in daily occupations (Parham, 2002). For example, a child who has difficulty processing tactile information from his or her hands is likely to have difficulty with handwriting and manipulating toys. Common areas associated with poor sensory processing include: academic achievement, personal identity, activities of daily living, behavior, and social participation.

Academic Achievement

Learning is a function of the brain that requires successful processing of sensory information in order to contribute to the development of the underlying skills needed for attention, comprehension, and organization of multiple sensory inputs (Ayres, 2005).

Personal Identity

Participating in activities within a culture typically requires the development of skills and abilities that are based on sensory and motor processes. A child's identity is often formed by his or her engagement and success in sports, hobbies, school, and socializing with peers. An absence or lack of success in these endeavors can often contribute to the development of a negative identity. The child may believe that he cannot write well, that she is bad at basketball, or that he is a poor student, and withdraw from typically rewarding cultural activities (Parham, 2002). Withdrawal from typical activities means fewer opportunities for learning skills and engaging in potentially rewarding activities.

Activities of Daily Living

Daily self-care routines often are affected by a child's responses to sensation; ability to understand and pay attention to the task; ability to perform the necessary fine and gross motor skills; and ability to plan, sequence, and organize the time and materials to perform these activities within a fast-paced schedule or a busy household. Dressing, eating, and grooming habits often are affected by sensory preferences or sensory avoidant behaviors (Dunn, 1999).

Behavior

Individuals with sensory integration deficits commonly have atypical or idiosyncratic behaviors related to their sensory preferences or dyspraxia (e.g., rigid routines around mealtime). Difficulties with self-regulation of emotion, attention, and capacity to cope with change, and stress that result in emotional and social control issues also are common (Smith Roley et al., 2001). As a result, the child's behavior may further alienate and isolate him or her from peers and family.

Social Participation

Navigating the world of people is vastly more complex than anything else we have to negotiate in life. People move around, change the rules, and are unpredictable. Often, the socially constructed ways to fit in and engage change too fast for a child with a disability. The rules are often unspoken, and the boundaries of conformity are invisible. Children who have difficulties perceiving, tolerating, and integrating sensations are more likely to have difficulties negotiating the unpredictable and changing stimuli involved in social activities.

Applying the Sensory Integration Principles in Assessment and Intervention

How do I use the sensory integration frame of reference in a therapy practice?

Sensory integration theory is applied within the guidelines of overall professional practice. The *Occupational Therapy Practice Framework: Domain and Process* (AOTA, 2002) provides a comprehensive summary of the domains of concern and the process of delivering services. The following outline provides a step-by-step process for using this frame of reference in occupational therapy.

Step 1 Evaluation—Create an Occupational Profile

- Identify and document the occupation-related concerns

Step 2 Evaluation—Evaluate Occupational Performance

- Identify and document the sensory integration and praxis issues

Step 3 Intervention—Plan Intervention

- Identify and document the therapeutic action plan

Step 4 Intervention—Target Outcomes

- Identify and document objectives and goals linking engagement in needed and desired activities with areas that can be addressed through specific intervention strategies

Step 5 Intervention—Implementation

- Implement the plan in the target areas of person/activity/environment
- Direct client interactions
- Therapeutic activities
- Environmental modifications
- Document the ongoing results of the therapeutic dynamic assessment

Step 6 Intervention—Review

- Evaluate and document the results of the intervention
- Document achievements in identified areas
- Document achievements in reported areas, including the impact of therapy on the occupation and co-occupations of the family

Note: Although practice does not always proceed in this sequence, the steps provide a guide for the *clinical reasoning process.* In addition, it is common that more than one frame of reference will be employed in the therapeutic process. Using and integrating various frames of reference is outside the scope of this book.

Key Components of Sensory Integration Addressed During Assessment

Using factor and cluster analyses, Ayres identified several interrelated key components related to sensory integration theory that relate to functional skills and performance and can be observed or measured. The *Sensory Integration and Praxis Tests* (SIPT; Ayres, 1989) provided information about interrelated sensory, motor, and praxis functions that form the basic components addressed in therapy. Not only are the components of sensory processing and praxis considered when using this frame of reference, so are the interactions between sensations. Ayres also correlated performance on the SIPT with other measures of neuromotor, cognitive, and academic functions, theorizing that sensory integration provides a foundation for these higher-level functions as well. Table 1.2 lists the key areas that are assessed based on a sensory integration frame of reference.

Table 1.2
Key Components of Sensory Integration

Component	Description	Contribution to Function
Sensory Registration	Ability to detect information from the body and the environment	Most fundamental stage of perception that allows the individual to begin to process sensory information
Arousal	Alertness or wakefulness	Allows the individual to move easily through diurnal rhythms and stay calm and alert while awake and calm and restful while asleep
Sensory Modulation	The ability to adjust to the intensity and duration of a stimulus or multiple sensations	Comfort with variable intensities of sensations, ability to attend in the presence of multiple sensations
Sensory Discrimination	Ability to interpret the temporal and spatial qualities of sensation	Provides the individual with clear, rapid, and precise details, such as quality, quantity, location, size, and shape
Skill	Postural control; fine motor control of eyes, hands, and oral area; gross motor control	Motor control
Praxis	Ideation, motor planning, and execution	Figuring out what to do and how to do novel actions
Organization of Behavior	Organizing sequences of actions in time and space	Placing order to ideas, actions, and things that are needed now and in the future

Areas of Sensory Integration and Praxis Addressed During Intervention

Based on the assessment, the therapist determines the components of sensory integration and praxis (as listed in Table 1.2) that are the most appropriate targets for intervention. The therapist creates an environment that affords the child opportunities to engage in activities, and then scaffolds, or supports the child's play and interactions to facilitate performance. The therapist continually monitors the child's level of arousal while providing appropriate and meaningful challenges. If the sensory, motor, or praxis demands are too difficult or too easy, performance will be less than optimal. In cases where the child has more difficulty with sensory modulation and self-regulation, the child's level of arousal, stress responses, and regulatory abilities must be addressed so that the child can continue to enjoy the interactions in a playful fashion and accept the challenge to be adaptive in motor skills and praxis.

Table 1.3 shows the components of sensory integration (sensory registration, arousal, modulation, discrimination, skill, praxis, and organization of behavior) and how the therapist might scaffold the child's activities and performance to obtain the desired outcomes.

Table 1.3
Eliciting Adaptive Responses Through Scaffolding

Area of Focus	Therapeutic Adjustments	Outcomes of Therapeutic Adjustments
Sensory Registration	Begin analysis of the child's status here. Determine what aspects of the environment the child is and is not detecting. Reorganize the environment so that the therapist and child have mutual attention to something meaningful.	Improved attention to relevant aspects of people and things in the environment. Readiness to interact.
Arousal	Decide if current interactions are appropriate or need to be more stimulating or calming so that the child is in a calm alert state.	Improved levels of alertness and comfort with surroundings and one's own state.
Sensory Modulation	If needed, adjust intensity, duration, and variety of environmental stimuli.	Improved self-regulation of behaviors, emotions, and interactions.
Sensory Discrimination	Alter temporal/spatial sensory qualities of sensations.	Enhanced perception of broader perceptual field.
Skill	Grade challenge in fine and gross motor areas.	Improved ability to challenge gravity. Refinement of learned interactions with objects and people.
Praxis	Alter demand relative to creative ideas, sequence of steps, and adjustments based on novelty.	More automatic and dynamic planning of adaptive and complex interactions with objects and people.
Organization of Behavior	Adjust responsibility for increasingly complex tasks in time and space.	Improved ability to organize sequences of multiple temporal/spatial interactions both under current circumstances and in the future.

Relevant Outcomes and Effectiveness

Aspects of Function Expected to Change as a Result of Intervention

The ultimate goal of intervention is to improve the child's *occupational performance*, observed through his or her ability to participate in daily life activities, including social participation with family, peers, and others.

The components of occupational performance that are expected to change as a result of intervention include the following skills and abilities that provide a basis for participation in meaningful occupations:

- Increased fine motor, gross motor, and perceptual motor skills
- Improved play skills and playfulness
- Increased self-esteem
- Improved eye contact
- Increased spontaneous exploration, active participation with others and other forms of engaged behavior
- More purposeful activity
- Improved language
- Increased awareness
- Improved social and emotional behavior
- Decreased self-stimulatory behaviors
- Increased interactions with objects and people
- Increased sensory exploration of environment

Efficacy of Sensory Integration Principles and Methods in Intervention

Efficacy studies have shown varying results with regard to intervention using sensory integration principles (Ayres, 1976; Kinnealey, Koenig, & Huecker, 1999; Polatajko, Law, Miller, Schaaf, & Menab, 1991; Mulligan, 2003). These studies vary significantly with regard to the populations targeted, the expertise of the therapist doing the intervention, the length and the style of the intervention, and the outcome variables. While effectiveness has not been proven, it has not been found to be ineffective or harmful either (Miller, 2003; Parham & Mailloux, 2005). Further studies are needed that:

- carefully identify the population,
- adhere to clearly defined sensory integration treatment principles,
- evaluate intervention performed by therapists certified in sensory integration, and
- identify and measure family-centered and occupationally relevant outcomes.

When is a therapist qualified to use the sensory integration frame of reference?

Postgraduate training in sensory integration theory, assessments, interpretation, and intervention resulting in Certification in Sensory Integration, including administering and interpreting the *Sensory Integration and Praxis Tests* (Ayres, 1989) is recommended. While most occupational therapists have had some exposure to the application of sensory integration principles to assessment and intervention in their entry-level professional programs, competencies in the use of sensory integration theory and its application are developed primarily through postgraduate continuing education, mentoring, and clinical experience. Occupational therapy assistants (OTAs) who choose to apply sensory integration principles during intervention should always do so under the direct supervision of an occupational therapist who specializes in sensory integration according to the guidelines established with their professional license/registration. OTAs are not eligible for certification in sensory integration.

To ensure that competencies in the application of sensory integration theory, and that skills learned through certification are honed and continually advanced, the following are recommended:

- experience using sensory integration methods, especially in the format of clinic-based services, is strongly recommended for a minimum of two years;
- mentorship, through supervision, consultation, and professional guidance by a therapist certified in sensory integration;
- ongoing study and review of the literature that supports sensory integration theory and its application; and
- ongoing feedback from professional peers who are also involved in using sensory integration as a frame of reference, as a check and balance for best practice.

CHAPTER REVIEW

This chapter presents an overview of the theory of sensory integration and the influence of sensory integration on development, behavior, and participation in meaningful activities or occupations. The constructs and outcomes of occupational therapy using a sensory integrative approach are identified and a system for applying this approach within the context of the *Occupational Therapy Practice Framework: Domain and Process* (AOTA, 2002) is presented. Finally, guidelines for therapists who would like to become proficient in this approach are outlined. The list below recaps the major points presented in this chapter.

- Sensory integration as a theory and frame of reference
- Principles of typical development
- Evolution of theory and practice
- Dynamic relationship of assessment and intervention
- SCSIT, SIPT, and related measures
- Clinical observations
- Who can benefit from intervention based on sensory integration theory and how

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